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Fostering Dental Students' Academic Achievements and Reflection Skills Through Clinical Peer Assessment and Feedback

Jorge A. Tricio, DDS, MS, PhD; Mark J. Woolford, BDS, MA, PhD;
Michael P. Escudier, MBBS, BDS, PhD

Abstract: Peer assessment is increasingly being encouraged to enhance dental students' learning. The aim of this study was to evaluate the educational impact in terms of academic achievements and reflective thinking of a formative prospective peer assessment and feedback protocol. Volunteer final-year dental students at King's College London Dental Institute, UK, received training on peer assessment, peer feedback, and self-reflection. At the beginning (baseline) and end (resultant) of the 2012-13 academic year, 86 students (55% of the year group) completed a reflection questionnaire (RQ). Sixty-eight of those students used a modified Direct Observation of Procedural Skills (DOPS) as a framework for peer assessment and peer feedback during a complete academic year. End-of-year, high-stakes examination grades and RQ scores from the participants and nonparticipants were statistically compared. The participants completed 576 peer DOPS. Those 22 students who peer assessed each other ≥ 10 times exhibited highly statistically significant differences and powerful positive effect sizes in their high-stakes exam grades ($p=0.0001$, $d=0.74$) and critical reflection skills ($p=0.005$, $d=1.41$) when compared to those who did not assess one another. Furthermore, only the same 22 students showed a statistically significant increase and positive effect size in their critical reflection skills from baseline to resultant ($p=0.003$, $d=1.04$). The results of this study suggest that the protocol used has the potential to impact dental students' academic and reflection skills, provided it is practiced in ten or more peer encounters and ensuring peer feedback is provided followed by self-reflection.

Dr. Tricio is Teaching and Learning Researcher and Lecturer, School of Dentistry, University of the Andes, Santiago, Chile, and Visiting Senior Lecturer, Education Directorate, King's College London Dental Institute, UK; Dr. Woolford is Professor of Education and Conservative Dentistry and Associate Dean for Education, King's College London Dental Institute, UK; and Dr. Escudier is Clinical Senior Lecturer in Oral Medicine, Department of Clinical and Diagnostic Sciences, and Deputy Director of Education (Student Assessment), King's College London Dental Institute, UK. Direct correspondence to Dr. Jorge Tricio, University of the Andes, Faculty of Dentistry, Av. Mons. Alvaro del Portillo 12.455, Las Condes, Santiago 7620001, Chile; +56 (9) 98182281; jorge.tricio@kcl.ac.uk.

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The clinical environment focuses health professions students on active learning from integrated problems and gives teachers the opportunity to model professional thinking, behavior, and attitudes. However, time pressures, competing demands, and increasing numbers of students may adversely affect this process. Current practice in medical workplace assessment has also been criticized for its absence of direct observation,¹ lack of informed and immediate feedback, difficulties in finding staff assessors,² and limited opportunities for reflection and discussion.³

In dental education, these potential limitations have encouraged the use of alternative methods such as peer assessment and peer feedback.^{4,5} In an educational framework, peer assessment involves

observation by students who have attained the same general level of training, expertise, and status to judge structured tasks or provide overall impressions of the amount, level, value, worth, quality, or success of their peers' work.^{6,7} Students are required to provide their peers with grades, feedback, or both,⁸ which can result in the provision of objective feedback,^{9,10} with the purpose of enhancing the observed and observing students' learning processes.

Peer assessment in higher education can aid students' learning, as well as help prepare them for independent and autonomous study, which supports lifelong learning.⁸ Peers are a key feature of learning in the workplace and in professional practice, as learning with and from peers is the dominant mode of everyday learning.¹¹ In health professions education,

peers are in an advantageous position to judge one another's clinical skills,¹² as they are constantly exposed to all aspects of their training.¹³ This increased exposure while performing the tasks and procedures being learned under real conditions¹⁴ allows peers to observe, assess, and provide feedback¹⁰ to each other in a less stressful manner than otherwise.¹⁵

The value of formative peer assessment in the development of predoctoral dental students' clinical competence in simulated tooth extractions was reported in one study.¹⁶ Preclinical students worked in pairs alternating roles of assessor and trainee, peer assessing and grading each other on given assessment criteria and, most importantly, providing verbal and written feedback. In that study, 10% of the students improved their peer assessment scores on the subsequent supervisor's summative assessment. Despite this, the potential benefits of peer assessment in dental education remain largely underexplored.

The aim of this study was to evaluate the educational impact of peer assessment, in terms of academic achievements and reflective thinking, on dental students over a full academic year of a continuous, formative, and structured peer assessment protocol of clinical performance. We hypothesized that the proposed protocol would have a positive educational impact and would stimulate the students' reflective skills.

Materials and Methods

The study received full ethical approval from the King's College London Biomedical Sciences, Dentistry, Medicine, and Natural & Mathematical Sciences Ethical Committee (reference number BDM/11/12-21). In September 2012 (baseline), all 155 fifth-year Bachelor of Dental Surgery (BDS) students enrolled at King's College London Dental Institute (KCLDI) received an electronic invitation to participate in the peer assessment and peer feedback exercise. The students were in the final year of the five-year BDS program. The exercise involved consenting students observing each other while treating their patients followed by a structured peer assessment protocol using specially designed workplace-based forms as previously described.¹⁷ To stimulate involvement of both intrinsically and extrinsically motivated students, all who took part in the study received a "Research Participation Certificate" signed by the KCLDI Director of Education for their portfolio and were offered entry to a drawing for a Kindle Fire HD.

The principal investigator (JT) delivered several 15-minute tutorials to provide a detailed explanation of the study's peer assessment protocol to all 155 students. Those students who consented to participate received a further 45-minute training and familiarization session on observation, peer assessment, peer feedback, action plan, and completion of the instrument followed by brief self-reflection. After a theoretical introduction on peer assessment, specially prepared videos of students treating simulated patients were shown to the participants. Working in pairs and based on the instructions and videos, students learned and practiced how to give (observing student) and receive (training student) confidential, brief, constructive, task-focused,¹⁸ and immediate dialogic feedback,¹⁹⁻²¹ using the peer assessment form domains as a framework.²²

Instruments and Data Collection

A previously piloted modified workplace-based form, the Direct Observation of Procedural Skills (DOPS), was used as a framework for the continuous and structured peer assessment and peer feedback protocol.¹⁷ The peer DOPS was designed for dental students to assess their peers' increasing ability over time to perform clinical procedures on their patients. The domains addressed 13 items in cognitive and clinical skills, communication, professionalism, and management, representing the main learning outcomes of the fifth-year coursebooks.

A SurveyMonkey online version of the self-reported Kember et al. survey was used in the study.²³ This reflection questionnaire (RQ) was used to examine the influence of the peer assessment and peer feedback protocol on the students' reflective skills. Participating students completed the RQ at the beginning (baseline) and at the end (resultant) of the 2012-13 academic year. The RQ quantitatively assessed two levels of non-reflective actions: Habitual Action, which is a previously learned response automatically performed with little conscious thought; and Understanding, which is cognitive learning and reading without appraising. It also assessed two levels of reflective actions: Reflection, which is an active, persistent, and careful critique of assumptions about the content or process of problem-solving; and Critical Reflection, which refers to becoming aware of why we perceive, think, feel, or act as we do.

To investigate whether those students who followed the peer assessment protocol represented the entire class (high and low achievers), their exami-

nation marks (grades) from the previous academic year (2011-12)—that is, before the peer assessment started—were compared to those from students who did not participate in the exercise. To establish the possible effects of the peer assessment and feedback protocol on the students' academic performance, their high-stakes end-of-year exam marks from the studied period were collected and subsequently correlated with the peer assessment variables. The high-stakes exams included essays on clinical scenarios, online multiple-choice questions (MCQs), an objective structured clinical exam (OSCE), a structured clinical reasoning exam (SCRE), and a case presentation.

During the 2012-13 academic year, participating BDS students organized themselves into pairs to work at each Primary Dental Care Clinic session. They acted as either dentist (trainee) or assistant (observer) in their usual clinical activities during the first half of the day and then reversed roles for the second half of the day. The assistant helped and observed the clinical procedure, using it for the formative assessment and as a grounded framework to provide informed written (in the actual peer assessment form) and verbal feedback. The pair also agreed on an appropriate action plan to address any developmental needs identified. Finally, after signing the peer-DOPS forms and placing them in a specially designed delivery box, the students reflected on the feedback and action plan and noted their thoughts in a private reflection diary. Participating students freely decided when to peer assess each other, whether to submit completed forms in the delivery box and the number of encounters to complete, and whether to stop participating and ask for the return of their completed forms.

Data Analysis

Peer-DOPS forms data completed by the participating students were manually digitized by the principal investigator (JT) into a spreadsheet, whilst RQ responses were electronically downloaded from SurveyMonkey into the same combined spreadsheet. Scores from both RQs (baseline and resultant) and peer assessment were checked for normality assumptions using histograms and box plots before we carried out any parametric analysis.

Descriptive statistics were used to summarize participants' characteristics as well as the total number of observations and average of encounters per student. The RQs' reliability was quantified by computing the Cronbach's alpha coefficient, whilst

the reproducibility of peer-DOPS, as a clinical assessment, was determined with a generalizability study²⁴ since the observed students were assessed by different observing students. A one-way ANOVA test compared exam marks from the previous academic year of those students who followed the peer assessment protocol and those who did not.

The degree of educational impact of a teaching intervention is increasingly being expressed in the research literature as the "effect size."²⁵ It is known as d (average posttest minus average pretest/spread)²⁶ and has been described as a useful method for comparing the mean results on different measures, over time, or between groups, independently of the study sample size. The average effect size has been reported to be $d=0.40$,²⁷ which means that teaching increases the mean on an achievement test by 0.4 of a standard deviation. Furthermore, this value is today used as a gold standard on which to judge the effects of any educational study.²⁸ Accordingly, the educational impact of the peer assessment protocol was studied through independent-samples t-test and effect size (d) on progress,²⁷ comparing students' end of year assessment marks for those who participated in the peer assessment protocol with those who did not.

Furthermore, the protocols' influence on the students' reflective skills was investigated using effect size and a paired-samples t-test, by comparing baseline (2012) and resultant (2013) students' RQ scores from those students who did and did not participate in the peer assessment protocol. All analyses were carried out using SPSS version 21 (IBM, Chicago, IL, USA), except for the generalizability coefficient, which was calculated using EduG 6.1e (Neuchatel, Switzerland).

Results

A total of 86 fifth-year students (56 females and 30 males; mean age=24.9, SD=2.8) participated in the study (55% of the year group). Of these students, 68 agreed to take part in the peer assessment protocol, whereas the remaining 18 completed both baseline (2012) and resultant (2013) RQs but did not take part in the peer assessment protocol.

Those 68 students who peer assessed each other completed a total of 576 peer-DOPS forms during the entire academic year (ranging from 1 to 27, with an average of 8.5 forms). The absolute generalizability coefficient for the peer-DOPS forms reached a score of 0.711, which is generally acceptable for

Table 1. Number (%) of students participating and number of peer assessment of Direct Observation of Precedural Skills (peer-DOPS) encounters completed

Group	Students N (%)	Peer-DOPS N (%)	Average Encounters Per Student
1-4 completed forms	28 (41%)	75 (13%)	2.7
5-9 completed forms	18 (27%)	113 (20%)	6.3
≥10 completed forms	22 (32%)	388 (67%)	15.4
Total	68 (100%)	576 (100%)	8.5

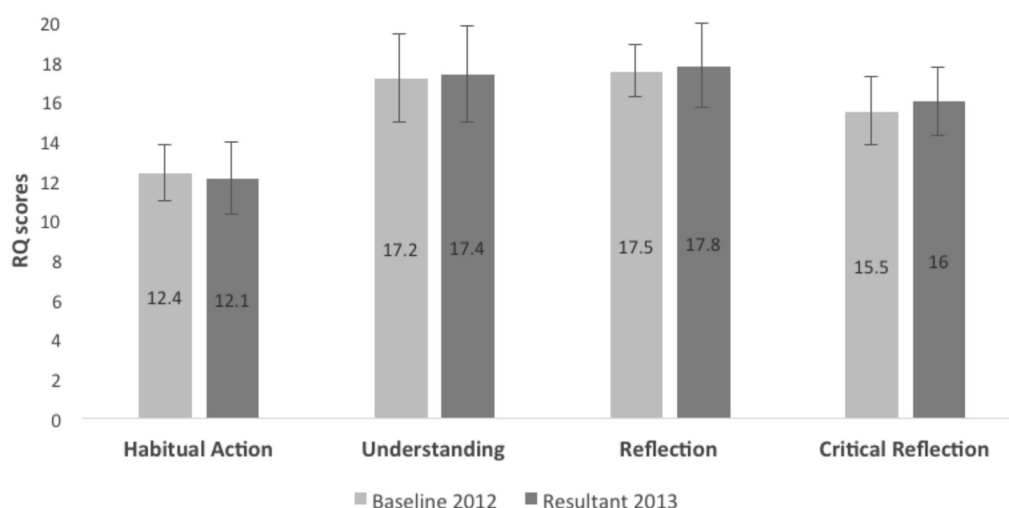


Figure 1. Mean score and standard deviation for four scales of Reflection Questionnaire (RQ) of all 86 students who completed questionnaire

low-stakes situations.²⁹ As a consequence of the wide range of peer assessment encounters, participating students were divided into three groups according to the number of peer-DOPS they handed in: between one and four; between five and nine; and ten or more forms (Table 1). The baseline (2012) and resultant (2013) RQs alpha coefficients were 0.702 and 0.731, respectively, suggesting an acceptable reliability. Scores from all 86 students who completed both RQs are shown in Figure 1.

Educational Impact

The previous academic year average exam marks of those 68 volunteer students who followed the peer assessment protocol was 60.8 (SD=4.1), while those 87 students who did not participate in the exercise had a similar 60.5 (SD=4.7). The same previous academic year average exam marks for

those participating students according to the number of peer-DOPS encounters was 60.0 (SD=4.1) for the 28 who completed between one and four forms; 60.5 (SD=4.6) for the 18 who completed between five and nine forms; and 61.6 (SD=4.1) for the 22 who completed ten or more peer encounters. The one-way ANOVA test revealed no statistically significant differences for the average of all the previous academic year exams ($F=0.783$, $p=0.562$), essays on clinical scenarios ($F=1.051$, $p=0.388$), online short-answer questions, short note questions, MCQs ($F=0.838$, $p=0.524$), and the OSCE ($F=1.648$, $p=0.147$). This result indicates that all studied groups began the intervention in similar conditions.

The protocol's educational impact was assessed by the statistical significance (independent samples t-test) and effect size of the differences between the end-of-year exams of those students who used the peer assessment protocol versus those who did not.

Table 2. Students' end-of year grades (2013)

Group	Average All Examinations			Clinical Scenarios				Online MCQs				OSCE		Clinical Reasoning Examination				Case Presentation	
	N	Mean (SD)	p	d	Mean (SD)	Diff. with No Peer Assessment Group	p	d	Mean (SD)	Diff. with No Peer Assessment Group	p	d	Mean (SD)	Diff. with No Peer Assessment Group	p	d	Mean (SD)	Diff. with No Peer Assessment Group	
All class	155	61.3 (4.2)	0.279	0.15	61.3 (5.0)	0.326	0.13	62.8 (5.3)	0.250	0.16	56.6 (4.0)	0.463	-0.10	64.3 (8.5)	0.432	0.11	61.7 (8.4)	0.424	0.11
Peer assessment	68	62.2 (4.5)	0.028	0.36	62.2 (5.2)	0.066	0.30	63.9 (5.4)	0.030	0.36	56.9 (4.3)	0.873	-0.03	65.6 (8.9)	0.152	0.24	63.0 (8.5)	0.106	0.27
1-4 completed forms	28	59.9 (3.9)	0.319	-0.22	59.9 (5.4)	0.436	-0.17	61.9 (6.1)	0.887	-0.03	55.6 (3.7)	0.125	-0.34	62.4 (6.9)	0.436	-0.17	60.6 (8.0)	0.890	-0.03
5-9 completed forms	18	62.4 (3.3)	0.128	0.45	61.6 (2.9)	0.502	0.19	64.1 (4.6)	0.172	0.40	56.2 (4.3)	0.530	-0.18	66.4 (7.0)	0.207	0.37	65.0 (8.3)	0.079	0.50
≥10 completed forms	22	64.9 (4.0)	0.0001*	0.74*	65.2 (4.7)	0.0001*	0.89*	66.2 (3.9)	0.0004*	0.80*	58.1 (4.1)	0.299	0.24	68.3 (8.3)	0.011*	0.59*	62.9 (8.6)	0.272	0.25
No peer assessment	87	60.7 (3.7)	-	-	60.7 (4.7)	-	-	62.1 (5.1)	-	-	57.0 (4.5)	-	-	63.7 (7.6)	-	-	60.8 (8.2)	-	-

Note: Shown are mean score, standard deviation (SD), difference (p), and effect size (d) when comparing all groups to the 87 non-participating students (no peer assessment) for each of the end-of-year examination grades, according to whether students participated in the peer assessment exercise and the number of peer assessment encounters completed.

MCQs= multiple choice questions, OSCE=objective structured clinical examination

*Statistically significant results based on independent-samples t-test (p-value) and effect size (d); only the most significant results are indicated

Those 68 students who used the peer assessment protocol showed a statistically significant difference ($p=0.028$) and a positive effect size ($d=0.36$) in their average on all exams (mean=62.2, SD=4.5) when compared to the 87 students from the same class who did not take part in the peer assessment study (mean=60.7, SD=3.7) (Table 2). Comparing these marks to those from the previous academic year, we see a difference of 1.4 points for those who used the peer assessment protocol and 0.2 for those who did not participate in the exercise. This finding indicates that those students who peer assessed each other increased their marks more than those who did not.

More specifically, the scores of the 22 students who peer assessed each other ten or more times exhibited highly statistically significant differences and powerful positive effect sizes (when compared to the 87 students who did not participate in the peer assessment protocol) in their average of all exams ($p=0.0001$, $d=0.74$), essays on clinical scenarios ($p=0.0001$, $d=0.89$), online MCQs ($p=0.0004$, $d=0.80$), and SCREs ($p=0.011$, $d=0.59$). However, this impact was not observed when we compared their OSCEs ($p=0.299$, $d=0.24$) with their case presentation ($p=0.272$, $d=0.25$) scores, as they obtained similar results in those (Table 2).

Influence on Reflective Skills

The influence of the peer assessment protocol was also assessed by studying the relationship between baseline (2012) and resultant (2013) students' reflection skills scores for the 68 students who used the peer assessment protocol and the 18 who did not. Once the RQ was completed, each participant received a score ranging from a minimum of 4 to a maximum of 20 for each Habitual Action, Understanding, Reflection, and Critical Reflection scale. Consequently, the higher the score, the more agreement with engaging in the particular dimension that each scale measures. Understanding and Reflection scores were higher both before (baseline) and after (resultant) the peer assessment exercise, indicating that students employed these levels of thinking more than Habitual Action and Critical Reflection.²³ It is worth noting that the RQ assessment was identical on the two occasions, so the baseline and resultant scores evaluated the real progress or regression on each of its four scales.

The results showed a statistically significant increase and positive effect size in students' Critical Reflection skills from baseline to resultant ($p=0.003$,

$d=1.04$) only for those 22 students who completed ten or more peer-DOPS encounters. A strong negative effect size was evident in the Habitual Action skills of those students with ten or more peer assessment encounters ($d=-0.65$) (Table 3), suggesting a move from automated responses to becoming aware of why they perceive, think, feel, or act as they do.³⁰ Finally, the same 22 students demonstrated a positive effect size and statistically significantly higher Critical Reflection ($p=0.005$, $d=1.41$) and Reflection ($p=0.014$, $d=0.78$) scores than the 18 students who did not peer assess one another (Table 4).

Discussion

This study evaluated the educational impact in terms of academic achievements and reflective thinking of a continuous, formative, structured peer assessment protocol of dental students' clinical performance, used as a framework for the provision of immediate peer feedback. As workplace-based performance is case-specific,⁷ the protocol was designed to be implemented on a continuous basis to facilitate multiple encounters and so increase the reliability of the results. Through direct observation, students practiced how to select good evidence³¹ to make judgments of their peers' process of patient care to provide accurate peer feedback during one complete academic year. Students were encouraged to go beyond the peer assessment "marking" part of the process, complementing this with a feedback or socially constructed learning component³² through which skills are developed.³³ In other words, we encouraged them to focus more on the learning than on the evaluation.^{1,34}

Our formative peer assessment results reached the generally accepted reliable coefficients of ≥ 0.7 for low-stakes situations²⁹ at eight encounters. This is in agreement with the conclusions of Williams et al.³⁵ in that a minimum of seven to 11 judgments of clinical performance were required for reliable findings. Our results also demonstrated the need for ten or more peer assessment and peer feedback encounters to positively impact students' academic performance. This finding may be explained by the requirement for students who engaged in the peer assessment and peer feedback protocol to take an active role in the management of their own learning.³⁴ Accordingly, students may have self-regulated their learning by monitoring their work using their repetitive peers' feedback as a catalyst and by expressing and articulating what they knew or understood.

Table 3. Students' baseline (2012) versus resultant (2013) reflection questionnaire (RQ) scores

Group	Habitual Action			Understanding			Reflection			Critical Reflection		
	N	Mean (SD)	p	d	Baseline vs. Resultant	Mean (SD)	p	d	Baseline vs. Resultant	Mean (SD)	p	d
All who completed the RQ (baseline)	86	12.4 (1.4)	0.695	-0.20	17.2 (2.2)	0.786	0.08	0.08	17.5 (1.3)	15.5 (1.7)	0.430	0.32
All who completed the RQ (resultant)		12.1 (1.8)			17.4 (2.4)				17.8 (2.1)	16.0 (1.7)		
Peer assessment	68	12.7 (2.9)	0.639	-0.20	17.2 (2.8)	0.733	0.11	0.11	18.1 (1.4)	15.6 (2.0)	0.514	0.25
With RQ (baseline)		12.2 (2.3)			17.4 (2.3)				18.2 (2.1)	16.1 (1.8)		
With RQ (resultant)		12.3 (2.5)	0.746	0.21	16.8 (3.0)	0.367	0.05	0.05	17.8 (1.5)	14.0 (3.5)	0.225	0.15
1-4 completed forms (baseline)	28	12.9 (2.6)			16.9 (1.9)				17.5 (1.8)	14.5 (2.3)		
1-4 completed forms (resultant)		11.7 (1.6)	0.985	0.02	16.5 (3.9)	0.274	0.18	0.18	16.9 (1.8)	14.3 (1.2)	0.603	0.46
5-9 completed forms (baseline)	18	11.7 (2.2)			17.6 (1.8)				18.1 (1.7)	15.3 (3.0)		
5-9 completed forms (resultant)	22	13.6 (2.9)	0.434	-0.65	18.1 (1.2)	0.940	0.10	0.10	18.8 (0.8)	16.4 (1.1)	0.003*	1.04*
≥10 completed forms (baseline)		11.9 (2.1)			18.3 (1.6)				19.2 (2.6)	18.0 (1.9)		
≥10 completed forms (resultant)												
No peer assessment	18	12.0 (1.5)	0.659	-0.24	16.4 (2.3)	0.624	0.27	0.27	17.6 (1.0)	15.4 (1.4)	0.899	0.00
With RQ (baseline)		11.6 (2.0)			17.1 (2.9)				17.7 (1.2)	15.4 (1.7)		
With RQ (resultant)												

Note: Shown are mean score, standard deviation (SD), difference (p), and effect size (d) for each of the four scales of the questionnaire according to whether students participated in the peer assessment exercise.

*Statistically significant results based on paired t-test (p-value) and effect size (d); only the most significant results are indicated

Table 4. Students' reflection questionnaire scores, 2013

Group	Habitual Action			Understanding			Reflection			Critical Reflection		
	N	Mean (SD)	p	d	Diff. with No Peer Assessment Group	Mean (SD)	p	d	Diff. with No Peer Assessment Group	Mean (SD)	p	d
All who completed the questionnaire	86	12.1 (1.8)	0.659	0.29	17.4 (2.4)	0.798	0.10	0.10	17.8 (2.1)	16.0 (1.7)	0.562	0.36
Peer assessment	68	12.2 (2.3)	0.627	0.29	17.4 (2.3)	0.764	0.11	0.11	18.2 (2.1)	16.1 (1.8)	0.521	0.31
All participating students		12.9 (2.6)	0.252	0.57	16.9 (1.9)	0.845	-0.09	-0.09	17.5 (1.8)	14.5 (2.3)	0.342	-0.48
1-4 completed forms	28	11.7 (2.2)	0.920	0.06	17.6 (1.8)	0.699	0.19	0.19	18.1 (1.7)	15.3 (3.0)	0.920	-0.05
5-9 completed forms	18	11.9 (2.1)	0.823	0.18	18.3 (1.6)	0.230	0.49	0.49	19.2 (2.6)	18.0 (1.9)	0.005*	1.41*
≥10 completed forms	22											
All non-participating students	18	11.6 (2.0)	-	-	17.1 (2.9)	-	-	-	17.7 (1.2)	15.4 (1.7)	-	-

Note: Shown are mean score, standard deviation (SD), difference (p), and effect size (d) for each of the four scales of the questionnaire according to whether students participated in the peer assessment exercise.

*Statistically significant results based on independent-samples t-test (p-value) and effect size (d); only the most significant results are indicated

Students in this study may have taken a proactive³⁶ (rather than reactive) role in developing their objectivity in the continuous exercise of observing and providing feedback on their peers' work, which could have then been transferred to their own clinical work, enhancing their learning¹¹ and potentially improving their performance on high-stakes assessments.³⁴ This may also explain the statistically significant increase and positive effect size in reflective skills for those students who completed a higher number of peer assessment and peer feedback encounters compared to those who did none.

The 22 students who performed ten or more peer-DOPS exercises demonstrated both significantly better performance and large effect sizes²⁶ in their high-stakes clinical scenario essays, MCQs, and SCREs when compared to the rest of their class (Table 2). This was despite those students having started the academic year in similar conditions as demonstrated by their previous year exam marks. Furthermore, and despite the fact that the same group of 22 students had the highest Reflection scores at baseline (Table 3), the significant increase of 1.6 points from 16.4 to 18.0 in their Critical Reflection skills was not seen in any other group (Table 3). This could be interpreted as a move from automated responses to becoming aware of why they perceive, think, feel, or act as they do,³⁰ and it could be the reason why they completed more peer encounters. A different interpretation may be that students need to have an active, persistent, and careful critique of assumptions about the content or process of problem-solving, a characteristic of Reflection skills, in order to further develop the higher order skill of Critical Reflection, and the iterative peer feedback and self-reflection exercise can help in this process.³⁷

Essay and clinical reasoning exams have in common the requirement that students solve problems or cases. Hence, as shown by Mezirow,³⁸ this process leads to higher order thinking, as the central dynamic involved in problem-solving is reflection. The imperceptible impact of the peer assessment protocol on OSCE scores was unforeseen. However, this finding was similar to that in another study in which OSCE scores correlated to students' Habitual Action and Understanding but not to Critical Reflection.³⁹ Enhanced clinical learning may also be related to Kolb's four-stage experiential learning cycle by which knowledge is created through the "transformation of experience."⁴⁰ These fifth-year students spent 70% of their time working with patients in the clinic, which allowed their reflections to be tested in practice directly afterwards and on a daily basis.

The participating students may have reached the Critical Reflection level of thinking as they were working and practicing the peer assessment protocol in the very relevant and problem-centered environment of the patients' clinic. According to Dewey's theory of reflective thought and action,⁴¹ they may have been most motivated to reflect in order to resolve the conflict when facing the "inadequacy" or "state of uncertainty" (that is, failures and difficulties) of clinical results.⁴² Academically important, critical reflection is highly unlikely to happen without the pressure of inadequacy and facilitation through others.^{43,44}

Those 22 participating students with ten or more peer encounters showed an effect size of $d=0.74$ for the average of all their end-of-year assessments when compared to those students who did not participate. Unfortunately, there are no similar published studies to which we can compare the educational impact of our protocol. The closest would be the study of Ali et al. in which 10% of the preclinical students improved their summative assessment score after a peer assessment and peer feedback exercise.¹⁶

More evidence can be obtained from a meta-analysis of 41 studies on medical clinical performance in which 32 of the articles demonstrated a positive impact of feedback, but the variation in outcome variables impeded any systematic analysis of effect sizes.⁴⁵ Significantly, a meta-analysis of feedback interventions by Kluger and DeNisi found the average effect size of feedback interventions across four groups of variables (cues, task characteristics, situational, and methodological) to be $d=0.38$, although peer feedback or peer tutoring was not included.¹⁸

There are also some practical reasons to implement a peer assessment and peer feedback protocol. In the presence of resource constraints and staff problems with providing sufficient feedback,³⁴ peer assessment can help to overcome the frequently reported lack of immediate feedback in workplace-based assessment as well as difficulties in finding a staff assessor.² Given these points, peer assessment and peer feedback have significant potential in the current dental education setting. A frequently mentioned innovation in preclinical and clinical dental education is that of students working in pairs or teams, mimicking the real working environment^{46,47} and assisting others to learn. Thus, implementation of peer assessment and peer feedback in such naturalistic settings would mean simply organizing a protocol without any changes in curricular content, which otherwise would mean losing an opportunity to foster students' academic and reflective skills.

Our study had some limitations, including the small sample size and that the study was conducted at only one school, and therefore our results should not be generalized. The most evident limitations were that the participants were volunteers and the groups were not randomized. This limitation might suggest that those students who completed ten or more peer encounters were the more motivated ones. Future research may address some variables that this study did not contemplate. Peer assessment and peer feedback information could be used for early exposure of those students who need tutor remediation. Furthermore, as suggested by some students in this study, allocating specific time slots at the end of the session to allow peer assessment and peer feedback, as well as moving to electronic peer-DOPS forms, could attract more students or even allow them to complete more encounters. Electronic implementation may also ease the excessive amount of time and effort required to implement and monitor our protocol. In addition, it may help to show whether peer assessment or reflective skills scores have any predictive value in identifying students who will do well in the clinic and in their future professional life.

Conclusion

Despite its limitations, this study found that using a peer assessment and peer feedback structured protocol has the potential to impact dental students' education, provided it is practiced during ten or more peer encounters and ensuring peer feedback is provided followed by self-reflection. In this instance, improvement of students' academic and reflective skills can be expected. The results suggest that dental students can be given more responsibility to take an active role in the low-stakes formative phase of their learning by moving from being passive students to active trainers, especially if the aim is to teach them to self-regulate and control their learning and thus to be prepared to manage their own education into their future careers.

Disclosure

The authors reported no conflicts of interests related to this study.

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